Engineering Case Library

ECL 143

INDIVIDUALITY PROJECTED

Abstract

The procedures followed by Thomas E. Osborne in developing and selling an electronic desk-top calculator are described. The logical design of a hypothetical Black Jack machine is included for illustrative purposes.

Written by Dr. Michael Kelly with support from the National Science Foundation. The cooperation of Mr. Thomas E. Osborne, Mr. Barney Oliver and the staff of the Electronics Research Labs of Hewlett-Packard is gratefully acknowledged.

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Individuality Projected

The ranks of the free-lancers are becoming thinner, but free-lancers are far from extinct as evidenced by the singular effort and subsequent success of an engineer named Thomas E. Osborne.

At the time of his graduation from the University of Wyoming in 1957, Tom was named the "Outstanding Electrical Engineer" of his class. Tom's first jobs included work on the design of data processing equipment. His work in industry was interrupted by a two year ROTC obligation in the Air Force followed by one year at the University of California in Berkeley where he received his M.S.E.E. in 1961.

Following his graduation from Berkeley, Tom was employed by Addman* Corporation, a producer of mechanical desk-top calculators. Addman was feeling increasing pressure due to the emergence of the electronic desk-top calculators. Although none were yet on the market, it was obvious that they would be announced by a competitor within the immediate future. The executive officers at Addman decided that the company should quickly market a new electronic desk-top calculator. Tom, as a member of a review board, was charged with the responsibility of judging the acceptability of a prototype calculator which the Addman Corporation was thinking of purchasing. The board reviewed the prototype model; Tom cast the only negative vote. Apart from the fact that it was silent, Tom thought that the prototype electronic calculator had little advantage over its mechanical counterpart. Utilization of electrical components, he argued, should permit a vastly improved calculator and there was little evidence of such improvement in this calculator. The prototype which was reviewed had an efficient logic design, but the circuitry used to implement the logic had insufficient electrical margins to obtain a reliable operation. The characteristic that bothered Tom the most was the time required for each arithmetic operation. The prototype was no faster than a mechanical calculator, and Tom believed that the speed should be improved by a factor of fifty. "It was," Tom said, "like giving a man wings and telling him that he could not fly." Tom's one vote as a junior engineer carried very little weight, and Addman decided to go ahead with the purchase of the prototype and develop it further. According to Tom, the Addman Corporation withdrew the electronic calculator that it had marketed within two years, and it is doubtful that the company reclaimed its original investment.

Tom refused to work on the development of the prototype calculator. Instead, he proposed that time be given to him to explore his own ideas of a generalized technique for the design of digital systems developed by him while a student at the University of California. Tom contacted an attorney who helped him to draw up a document which, if agreed to by Addman, would have permitted him office space and technical assistance in return for which Addman would receive Tom's working hours without pay and refusal right to anything that Tom might invent. The refusal right gave the company the option to buy anything developed at a price equal to that offered by any other interested party. It cost Tom several hundred dollars in lawyer's fees to draft the agreement which he thought to be equitable; he was, therefore, disappointed when Addman showed no interest in his proposal. Tom felt that he had no choice but to resign from Addman; however, when he made his intentions known, he was subjected to an "intensive debriefing." Because of statements he had made, Addman believed that Tom had actually been working on the development of a calculator. Tom repeatedly attempted to explain that his previous statements were a logical consequence of his design concept and that he had not been secretly working on a calculator of his own. Some of the people at Addman found this difficult to believe and continued to exert pressure on Tom until, as he explained it, "I was pushed out of shape." In order to protect himself against any further legal entanglements with Addman, Tom consulted his lawyer and had a document drawn up which ended the altercations and freed Tom from the possibility of any future legal conflicts with Addman.

In January of 1964 Tom, now unemployed, decided to take a two week vacation. He spent most of this vacation thinking about what he would do. After returning home Tom made his decision: he would design and build his own calculator. When Tom's friends at Addman heard of his intention to become an entrepreneur, there were many skeptics who thought the decision was a foolish one. Not all, however, were of the same mind. One man who believed in Tom was Ken Peterson, a technician who had worked with him at Addman. "I really thought that he would do it," said Ken. "Tom is bullheaded enough to accomplish what he sets out to do. He is

*Fictional name.

and one day I received a call from a representative of a calculator manufacturer who offered me a salary one-and-one-half times anything I had ever made before. It was a tempting offer to a man who had zero income, but I made up my mind that I would finish what I had started. I had no assurance at the time that there might be a return on the many hours and modest sum of money invested, but it was something that I had to do.

"Almost one year to the day after starting the calculator I got down to the serious business of trying to find a buyer for my invention. I began by writing a one page letter (Exhibit 1) to the presidents of fifteen companies informing them of what I had done and requesting that they forward an enclosed description of the calculator (Exhibit 2) to the appropriate persons within their respective companies. My letter was addressed to the presidents rather than to the engineering departments because I knew from experience that engineers are prone to give greater attention to information which comes to them from top management. I received replies from about ten companies. It is significant that the two company presidents who answered my letter personally were Thomas Watson of IBM and William Hewlett of Hewlett-Packard.

"I knew what I was looking for in the firm to which I would sell the calculator. I wanted to be certain that the company had a good engineering staff capable of absorbing and extending the concepts that were incorporated into my calculator. I also felt that it would be necessary for the company to have an excellent manufacturing capability and the ability to do a proper marketing job. Of the three, the manufacturing capability seemed most important.

"Prior to inviting any firm to send representatives to visit me in my apartment, where I had encased the calculator in a nondescript covering of green balsa wood, I visted my patent attorney and began the process of filing for a patent. He also drew up a statement which I insisted most companies accept before I agreed to make any disclosures.* (Exhibit 3)

"During the demonstrations that I gave in my apartment I protected my interests further by recording the conversations on tape, and I also hired a graduate student from Berkeley as a witness. The interest manifested by the firms that sent representatives was less than overwhelming, but during a period of about six months I learned much about the personalities of different companies—and each one definitely has its own personality! There were some representatives who could make no decision without first calling the home office for authorization, while others suggested immediate agreements. Inevitably I received a job offer and some companies offered a cash settlement to repay me for the work and parts that had gone into the machine. I realize now that the money they offered was considerably less than it would have cost the company to have its own engineering staff do a similar amount of work. I also know now that each company was appraising me on a make/buy basis. If there was any possibility of the company arriving at the same place for the same investment, there would have been no interest in the product. When working alone it is possible to produce at a faster pace because you are not retarded by the necessity of working within a multifarious structure where much of your time is spent communicating with others. One of the companies with whom I dealt had the only electronic calculator on the market. It was an education to deal with the representative of that company. He was a very personable individual but also a hard-nosed business man. He did not really want the calculator, but he realized that what I had might pose a serious threat to the calculator manufactured by his company. There were repeated negotiations until I finally realized that all the talk was simply a ruse to stall me as long as possible.

"While I was demonstrating my invention to potential customers, the letter which I had written to William Hewlett was being circulated at Hewlett-Packard. Within a short time I communicated with Ronald Potter of the Frequency and Time Division (Exhibit 5). No interest was shown, however, until an acquaintance of mine, Tony Lukes, spoke to Paul Stoft, manager of the Electronics Research Labs. Tony and I had worked together at Addman, and Tony told Paul that he had a friend who had a small desk-top calculator that might be of interest to Hewlett-Packard. Paul called me and asked for a demonstration. In November of 1965 I packed the green balsa wood package containing the calculator and went to Palo Alto. Paul was intrigued with some of the novel features of the calculator and he invited me back to give a demonstration to Barney Oliver, Vice President for Research and Development, William Hewlett, the President of Hewlett-Packard, and David Packard, Chairman of the Board. I was

*The International Business Machines Corporation preferred to use its own format (Exhibit 4) but the essence was the same as the statement which I had drawn up. IBM's acceptance of my conditions made it considerably easier to get other companies to agree to the same terms.

asked about the possibility of incorporating other features into my machine and interfacing it with work that was being conducted at Hewlett-Packard, and when I indicated that I thought it was possible, I was asked to give Hewlett-Packard six weeks to consider the proposal. Almost two years to the day after the project started, Hewlett-Packard agreed to purchase the existing calculator and hired me as a consultant to work on incorporating their ideas into the calculator. Although there were other companies to whom I might have sold the calculator, I consider myself fortunate to have gone with Hewlett-Packard. The company, within two and one-half years marketed a calculator, the 9100A, which far exceeded my fondest expectations."

The flow charts, logic and circuit designs of Tom Osborne's calculator would fill a small book, and even then, these would only represent the completed design and would not reflect the maze that preceded the finished product. According to Tom, the amount of do's versus do not's is a ratio of about one to four.

An interesting footnote to this story is that the technician, Ken Peterson, moved to Hewlett-Packard before Tom began negotiating with the company and Ken ultimately played a very important role while working with Tom on the 9100A project.

The Hewlett-Packard Journal, September 1968 issue, describes the development and outstanding features of the 9100A calculator.

ECL 143

5 LOGIC

DESIGN CO.

LOGICAL DESIGN
DIGITAL CIRCUITRY
DIGITAL SYSTEMS

P.O. BOX 3036
BERKELEY 5, CALIFORNIA
(415) 849-0315

6 March 1965

Mr. William R. Hewlett, President
Hewlett-Packard Company
1501 Page Mill Road
Palo Alto, California

Dear Mr. Hewlett:

I am enclosing a brief, semi-technical description of an electronic desk calculator developed by my company. Since we are not a manufacturing facility, I am interested in selling the rights to someone who is capable of manufacturing the device.

I would like to have your assistance in directing the enclosed information to the appropriate parties so that we can arrange a demonstration on the working model of the calculator and exchange other information your people will require to properly assess the unit.

Sincerely yours,

Thomas E. Osborne

Thomas E. Osborne
LOGIC Design Company

Enclosure

TEO:cdk

Exhibit I. Letter of Thomas E. Osborne to William Hewlett

LOGIC Design Company, a firm in Berkeley, California specializing in logical design and digital circuitry, has developed a solid state, floating point electronic desk calculator intended to sell in the $1600 to $1800 range. The machine employs a random access core memory to achieve a five millisecond addition time and fifty millisecond multiply and divide times. The unit weighs twenty-five pounds and is approximately six inches high by ten inches wide and fifteen inches deep. The lower power consumption of 25 watts is a by-product of the unique type of logic developed by the company.

A modified parenthesis free arithmetic notation allows most arithmetic expressions to be solved without transferring intermediate results between arithmetic registers. For problems requiring auxiliary storage and for storing constants, an expandable auxiliary storage area has been incorporated into the system.

A new packaging technique all but eliminates the interconnection problem common to logic systems. The diode gate resistors used in the logic circuits are all the same value allowing automatic component insertion equipment to operate efficiently. The system uses silicon transistors throughout. Either germanium or silicon diodes can be used in the logic gates. Germanium diodes were used in the prototype system. The system has been designed using modular techniques so that integrated circuits can be directly substituted for discrete component logic circuits when the price warrants such a change.

The system is designed to operate over a $15^{\circ}C$ to $55^{\circ}C$ temperature range with ±10% variations in supply voltages and component values.

Servicing the calculator is accomplished with a special testing unit. The capabilities of this inexpensive unit were demonstrated when the prototype was debugged without the use of any other test gear. Location of faults is greatly aided by the method used to describe the the system's logical design.

Exhibit 2. Description of the Osborne Calculator

LOGIC
DESIGN CO.

LOGICAL DESIGN
DIGITAL CIRCUITRY
DIGITAL SYSTEMS

P.O. BOX 3036
BERKELEY 5, CALIFORNIA
(415) 849-0315

26 April 1965

In consideration of the mutual review of the exterior features and operating characteristics of the electronic desk calculator shown to Ronald Potter, Section Leader, Hewlett-Packard Company, by Thomas E. Osborne, LOGIC Design Company, Thomas E. Osborne and Hewlett-Packard Company agree as follows: That for thirty (30) months from the date hereof Hewlett-Packard Company will refrain from selling or offering for sale an electronic desk calculator incorporating any of the external features and/or operating characteristics of said Osborne electronic desk calculator, which external features and/or operating characteristics were not known to Hewlett-Packard Company or to the public prior to the date hereof. Said features of the Osborne electronic desk calculator being fully set forth in Exhibit A appended hereto.

This agreement does not affect the right of Osborne to apply for a patent or patents nor does it affect the right of Hewlett-Packard Company to contest the validity of any such patents on grounds other than this disclosure. It does not grant Hewlett-Packard any license under any patents Osborne may obtain.

Signed: ______________________ Date: __________

Signed: ______________________
Thomas E. Osborne, LOGIC Design Co.

Exhibit 3. Agreement Drawn up by Osborne's Lawyer

IBM

Armonk, New York 10504
Telephone: 765-1900 (Code 914)

International Business Machines Corporation

Mr. Thomas E. Osborne
Logic Design Company
P. O. Box 3036
Berkeley 5, California

Dear Mr. Osborne:

To review your developments relative to exterior features and operating characteristics of an electronic desk calculator which is to be described to International Business Machines Corporation (IBM) by Thomas E. Osborne d/b/a Logic Design Company (LDC), it is agreed, as of March 1, 1965, that:

1) The exterior features and operating characteristics of the electronic desk calculator which LDC considers confidential information is fully described in the attached Exhibit A.

2) For a period of thirty (30) months from the date hereof, IBM will refrain from selling or offering for sale an electronic desk calculator incorporating any of the confidential exterior features and/or operating characteristics set forth in Exhibit A.

3) Information disclosed in Exhibit A will not be considered confidential which:

   a) is previously known to IBM;
   b) is publicly available;
   c) becomes publicly available; or
   d) is rightfully received from a third party.

4) No license is granted or implied to IBM under any patent or patents which LDC may have or obtain or affect in any manner LDC's right to apply for any patent by virtue of this Agreement.

Exhibit 4. Agreement Drawn Up by IBM

5) LDC's disclosure of confidential information shall not affect the right of IBM to contest validity of any LDC patent or patents other than on the basis of this disclosure.

If you are in agreement with the above, will you please so indicate by signing and returning one copy to Mr. Birchfield, together with Exhibit A.

Yours truly,

INTERNATIONAL BUSINESS MACHINES CORPORATION

By: W Birchfield

Accepted:

Thomas E. Osborne
Thomas E. Osborne

Date: 1 MARCH 1965

Exhibit 4. (Cont.) Agreement Drawn Up by IBM

LOGIC
DESIGN CO.

LOGICAL DESIGN
DIGITAL CIRCUITRY
DIGITAL SYSTEMS

P.O. BOX 3036
BERKELEY 5, CALIFORNIA
(415) 849-0315

22 April 1965

Ronald Potter
Hewlett-Packard Co.
1501 Page Mill Road
Palo Alto, California

Dear Mr. Potter

Since you have expressed limited interest in my calculator per se, I am curious to know what kind of a market you see for devices constructed around my techniques. Perhaps the best way to find out is to limit the initial disclosure to the exterior features and operating characteristics of the calculator so that you can get a feeling for the class of problems that I can solve. If you then see an appreciable market we can delve into the details of the system.

Sincerely yours,

Thomas E. Osborne

Thomas E. Osborne
LOGIC Design Co.

encl

Exhibit 5. Letter of Thomas E. Osborne to Ronald Potter of Hewlett-Packard

Design Procedures Illustrated

The following is an edited version of a speech which Tom Osborne gave in May of 1969. It is included here to give some indications of the procedures that Tom followed in the design of a digital system.

"I would like to limit the discussion to the design of a hypothetical machine--one that most of us will quite readily understand. Fig. 1 is an artist's conception of a '21' or Black Jack machine. I use this as an example because it contains many of the problems and many of the features found in the design of any digital system. For our purposes we will design the machine to play the same rules as those of the dealer. That is, the machine shall ask for a card by lighting the hit light as long as its score is less than 17. It will stand when its score is greater than 16 but less than 22, and it will go broke whenever the score is greater than 21. Face cards all have the value of 10 points. All other cards have their face value, except an ace, which may either have the value of 1 point or 11 points, whichever is to the advantage of the player. This last feature is the one that makes the problem interesting from a designer's viewpoint. With these as the ground rules, let us proceed with the design and go to Fig. 2.

"I am often asked how one starts the design of a system, and my answer is always the same--it doesn't make any difference--just start--the rest will fall in line of its own accord. Beginning then at the top of Fig. 2, we have a card reader with a binary output. It is important that some portion of the system know that there is a card present in the machine; hence, the line extending to the right called Card Present. Symbolically the signal is named YCRD, CRD being the abbreviation for 'card' and Y meaning the

card is present, i.e., Y for 'yes'. If the signal line indicated that the card were not present, I would have named it NCRD, N for 'no'. All of the status lines, those on the right side of Fig. 2, fall into the generic name of qualifiers.

"The output of the card reader is entered into the card register, identified in the center of the figure as flipflops 30 through 34. The information in the card reader is transferred into the card register by activating the instruction line TVC (transfer value into the 'C' register). The TVC circuitry must be designed such that the output from the card reader will be relayed into the 'C' register only when the instruction TVC occurs.

"The instruction T10 is used to force 10 points into the card register for incrementing the value of an ace from 1 point to 11 points. In the event that an 11 point ace is present and the machine goes broke, the ace should be reduced from 11 points back to 1 point. This could be done by subtracting 10 points from the sum or by adding 22 points to the sum, modulo 32. Although it is not evident that circuitry involved in transferring 22 points is less than the circuitry required to form a subtracter, assume that it is. Flipflop 50, YF50, is used to tell if an 11 point ace has been dealt. Flipflop 50 has set and reset instructions J50 and K50 respectively. As a sidelight, it is only necessary to count one ace as an 11 point ace. Any valid Black Jack hand can only support one 11 point ace. Two 11 point aces would exceed the upper limit of 21. Hence, the first ace will be counted as 11 points and all further aces will be counted as 1 point. It is also necessary to know that the current ace will be counted as 11 points. The qualifier YEPA (yes, eleven point ace) is made up of a

combination F50 = 0 and the C register = 0001. The next instruction, ADD, takes the information present in the card register and adds it to the information in the sum register placing the new sum back in the sum register. It is, of course, necessary to initialize the sum register to 0 at the beginning of a game, hence the instruction CLS (clear sum register). The last two qualifiers, YG21 and YG16, are necessary because a score of greater than 16 or greater than 21 is a cardinal point in a Black Jack game. Finally the instructions HIT, STAND and BROKE are used to light the lights on the front panel of the machine. This completes the system design of the instructions and qualifiers.

"In order to complete the design of our Black Jack machine, it is necessary to activate the instruction set in the proper sequence. Most of the sequence is controlled by the status of the qualifier lines. The question arises as to how to best express the 'proper sequence'. The notation shown in Fig. 3 has proven to be particularly effective. For all practical purposes Fig. 3 is the familiar flow chart used by most programmers. There are some differences which have resulted in many hours of discussion. One person has suggested that we do not call them flow charts. He suggests the name 'directed timing charts', since they are closely related to hardware and uniquely describe the sequential nature of its operation. Regardless of the name given to Fig. 3, the action is what counts--so let us proceed.

"The letters to the side of the boxes are used as identifiers and programming aids and will be called 'states'. In State A, for instance, two of the instruction lines, CLS and K50, are simultaneously activated to clear the sum register and to give the instruction K50. This initializes the sum register to 0 and removes any 11 point ace that was a carryover

from a previous game. Now assume that a couple of cards (two eights) have been dealt resulting in a score of 16 points. Also assume that we occupy State B. While in State B, the HIT light is turned on and the instruction TVC is continuously activated. Any card value that is present will be sent into the C register. If no card is present, garbage will go in. No harm is done, however, because as soon as a card is present, the garbage will be replaced by the value of the card present. All of the time the machine is occupying State B, the qualifier YCRD is being tested. As long as no card is present (YCRD = 0), control remains in State B. The main difference between a conventional flow chart and Fig. 3 is that both the qualifier (YCRD in State B) and the instructions in the state to which the qualifier is attached (HIT and TVC in State B) are simultaneously executed. In a conventional flow chart they would be considered to be sequentially executed. A second difference between Fig. 3 and a conventional flow chart is that any combination of instructions can be executed simultaneously, i.e., TVC and HIT in State B.

"As soon as a card is present, control goes from State B to State C and the value of the card present is locked in the 'C' register. Notice that TVC is not given in State C, hence the value in the 'C' register will not change after the card is gone. Control remains in State C as long as the card remains in the reader. Since the electronic portion of the system operates in the microseconds while the mechanical system is much slower, it is necessary to incorporate interlock or escapement mechanism shown in State C. Further processing is prohibited until the card is ejected when YCRD = 0 allows control to go from State C to State D. At this time the value of the card is added to the existing sum, e.g., 16. Let us assume

that the card is an ace. The score will be incremented then from 16 to 17 and the right exit out of State D will be taken. After setting flipflop 50 and transferring 10 points into the 'C' register in State E, control returns to State D where the 10 points is added to give a score of 27. Upon exit from D into F the question YG21 is asked to see if the score is greater than 21. Since it is, control goes from F to G. In G the flipflop 50 is set to zero by K50, and regardless of whether the score is greater than 21 or not, 22 is transferred into the 'C' register by T22. We are anticipating that an 11 point ace is present and that control will return to State D. If an 11 point ace is not present, the operation was redundant. Since flipflop 50 was set to a 1 in State E, control will return to State D where 22 points is added to the 27 existing point score, modulo 32, giving a score of 49 modulo 32 or 17. When control reaches State F, the score will not be greater than 21, hence control will go to J. YG16 is then interrogated to see if the score is greater than 16. If it were not greater than 16, control would go from J to B and a new card would be obtained. Our score of 17 causes control to go to State K where the STAND light is turned on. Control will remain in State K until a new game is initiated by inserting a new card in the machine at which time control goes from K to A. In the event that an 11 point ace was not in the score when we were in State G, control would have gone directly from G to H, and the BROKE light would have been turned on.

"State G demonstrates the significance of the difference between our flow charts and the standard flow charts. If the execution of our flow charts was totally sequential, then the K50 in G would set flipflop 50 to zero. The next sequential step, YF50, would never be met, and control would always go from the diamond to State H. The circuitry operates in a

manner such that the instruction K50 and the qualifier YF50 are simultaneously activated. One characteristic of a JD flipflop is that it is possible to command it to go to one state while simultaneously asking its present state without obtaining an interference of the two conditions. There are many ways of reducing the flow charts of Fig. 3 into hardware.

"For those of you who are hardware oriented, you will see that there are 10 states in the flow chart, hence at least 4 flipflops are required to identify these states. The particular combinations of these flipflops used to uniquely identify these states are shown as the binary addresses located above and on the right side of each of the ten states in Fig. 3.

"Fig. 4 shows State G of Fig. 3, as well as a coding sheet for the entire Black Jack game. State G is encoded in the fourth line from the bottom. The first entry, S0110, identifies State G as a binary address. If the qualifier YF50 is not met, control goes directly to State 0111. In the coding this corresponds to the second entry, D0111. When the qualifier is met, control goes to the alternate address 0011, hence the third entry A0011. The qualifier associated with State G is YF50 which appears as the antipenultimate entry while the two instructions executed from State G are K50 and T22. This line of coding totally defines everything that happens during the time interval that the binary address is sitting at 0110. It also defines where control will be in the time interval following.

"I believe that the flow chart in Fig. 3 is much more descriptive and easier to understand than the coding of Fig. 4. When microprogramming a digital system, one has more options at his command and needs the freedom offered by the flow chart to achieve maximum coding efficiency. Also, notice that the flow chart does provide its own documentation."

Figure 1. Illustration of Hypothetical Black Jack Machine

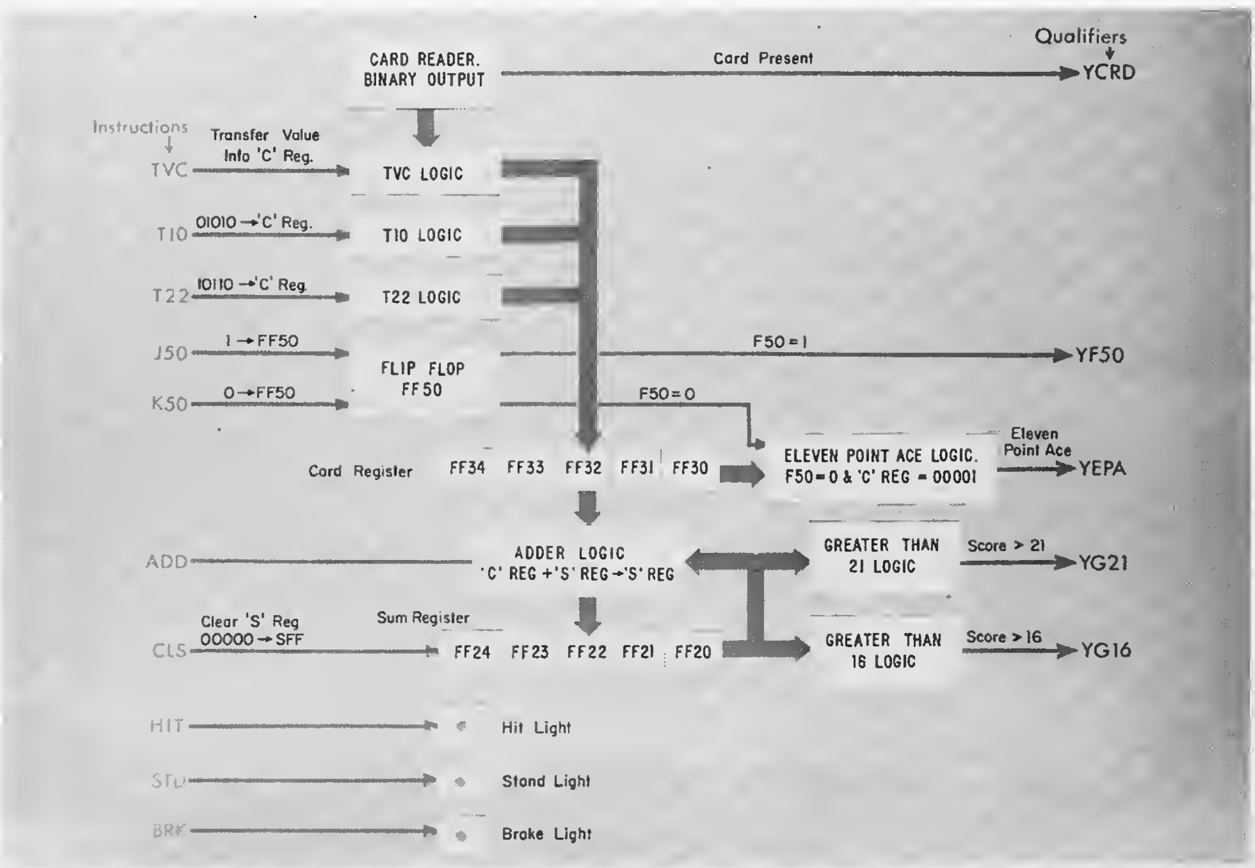


Figure 2. Logic Description of Black Jack Game

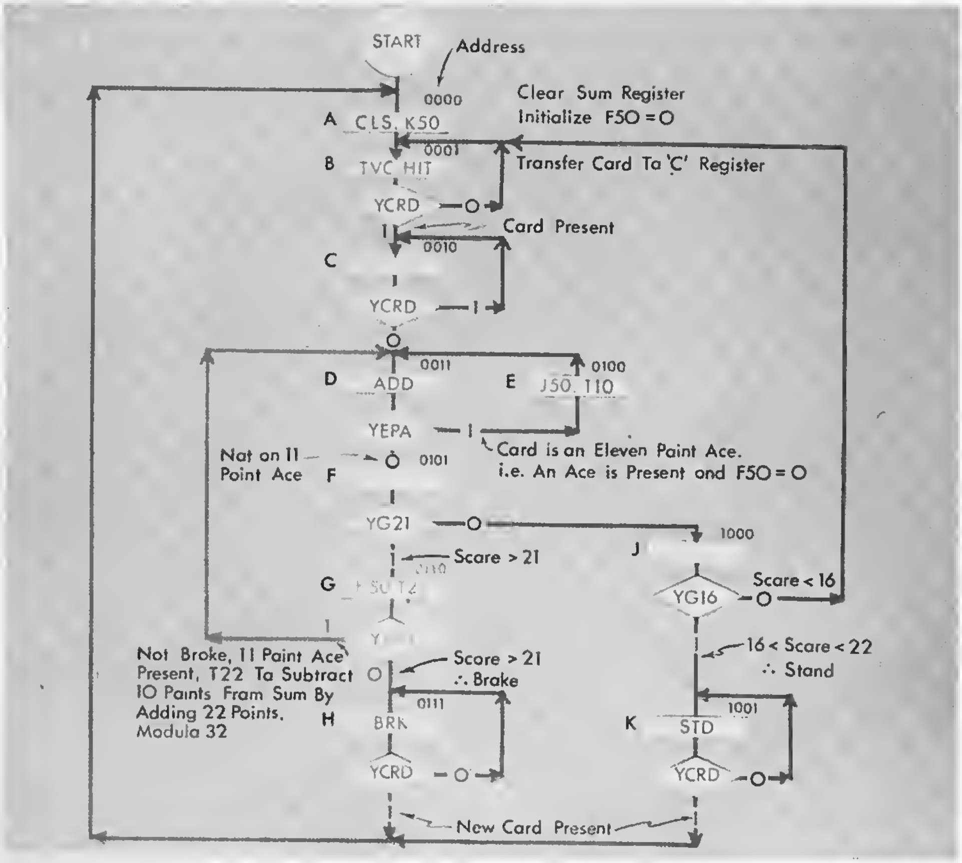
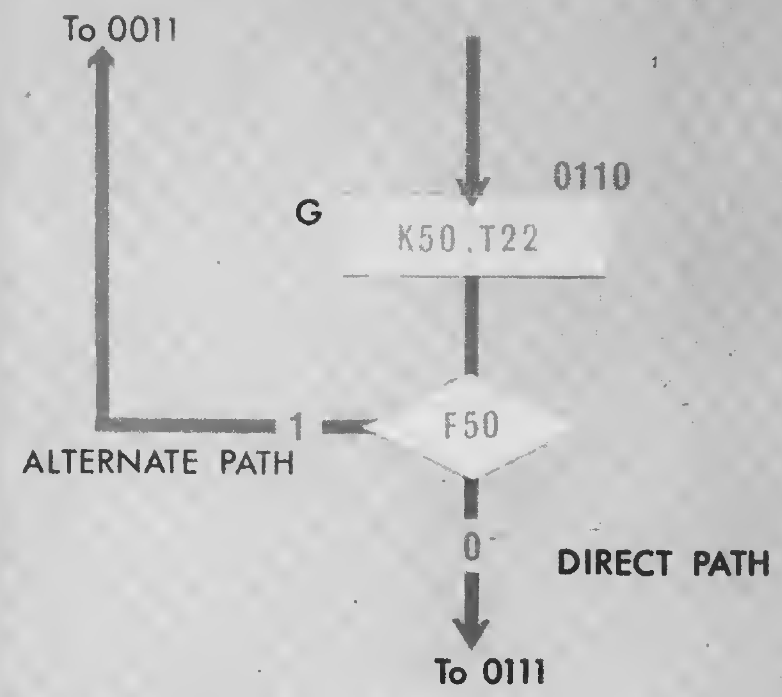


Figure 3. Flow Chart of Black Jack Game



S0000	D0001	CLS	K50	
S0001	D0001	A0000	YCRD	TVC
S0010	D0011	A0010	YCRD	
S0011	D0101	A0100	YEPA	ADD
S0100	D0011	J50	T10	
S0101	D1000	A0110	YG21	
S0110	D0111	A0011	YF50	K50 T22
S0111	D0111	A0000	YCRD	BRK
S1000	D0001	A1001	YG16	
S1001	D1001	A0000	YCRD	STD

Figure 4. State G of Figure 3. with Coding Sheet

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Teacher's Note

Suggested Topics for Discussion:

1. Conflict between an engineer's professional interests and company policy or goals.

2. The legal rights of a company. The legal rights of the engineer.

3. The marketing of an invention:
   a) Small company or large?
   b) Company with single line or a variety of products?
   c) Selling the rights versus finding financial backing.

4. Relationship between engineer and technician.

5. The importance of documentation.

6. The difference between logic design and circuit design.

7. The future of the design engineer.

Recommended Questions:

1. Would you consider a manufacturing capability more important than either engineering competence or marketing ability?

2. Is it usually better to complete the details of a design before testing?

3. As a company representative would you have any objections to signing the Exhibit 3 agreement?

4. What is significant about the presidents of H.P. and IBM writing personal letters?

5. What is your opinion of the tactic of the company representative who attempted to stall Tom Osborne?

6. How do you explain the remark "companies have personalities"?

7. Would you have replaced the nondescript balsa wood cover with something more elegant?

8. What are your impressions of the precautions taken to protect the inventor's rights?